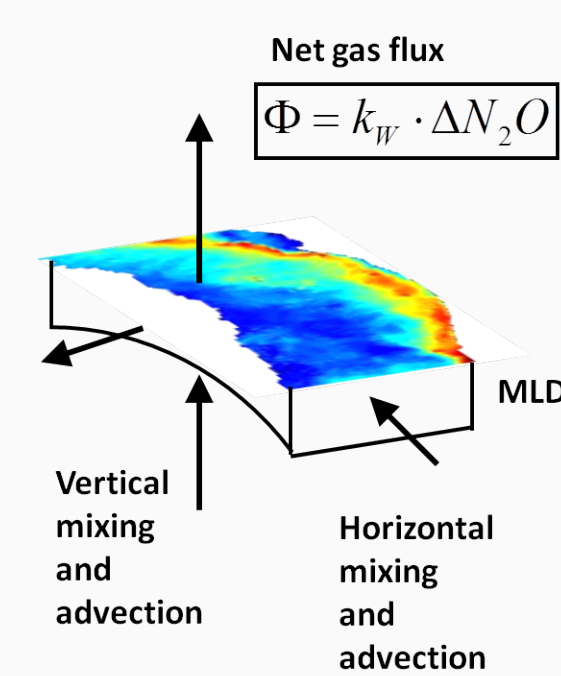


# Multi-day near-surface stratification and its impact on N<sub>2</sub>O emission estimates in the Peruvian upwelling system

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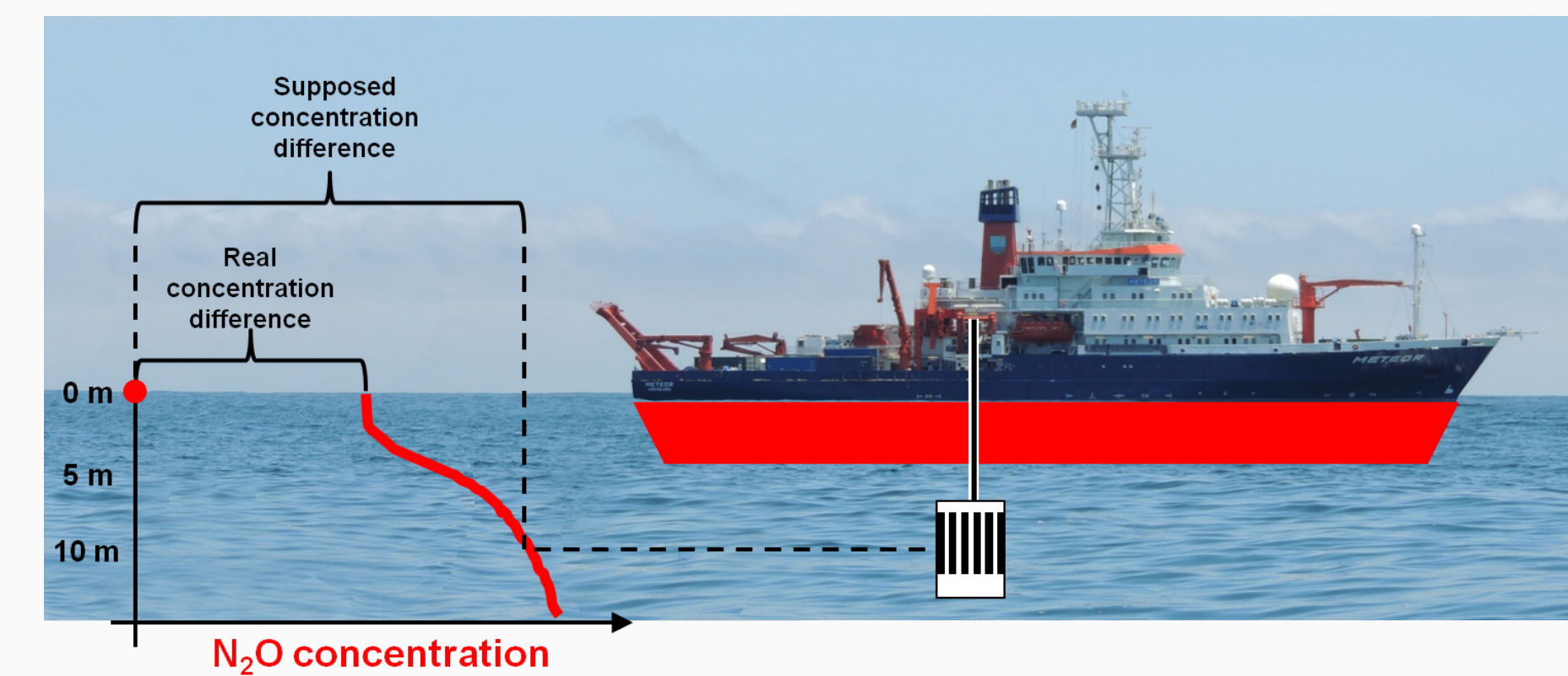
## Measuring nitrous oxide (N<sub>2</sub>O) in the top 10 meters of the Peruvian upwelling system

### Motivation



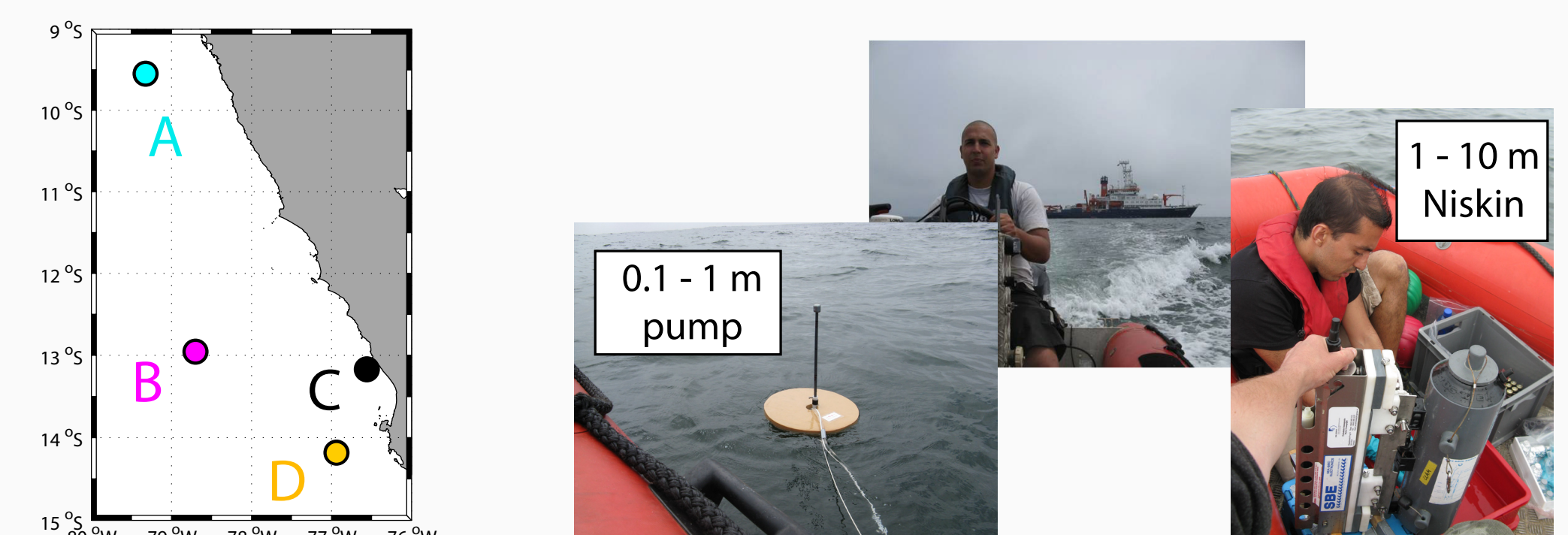
In the Mauritanian upwelling regime, N<sub>2</sub>O supply from below is much lower than the calculated N<sub>2</sub>O emissions. [Kock et al., 2012]

### Do we estimate gas emissions from adequate concentrations?



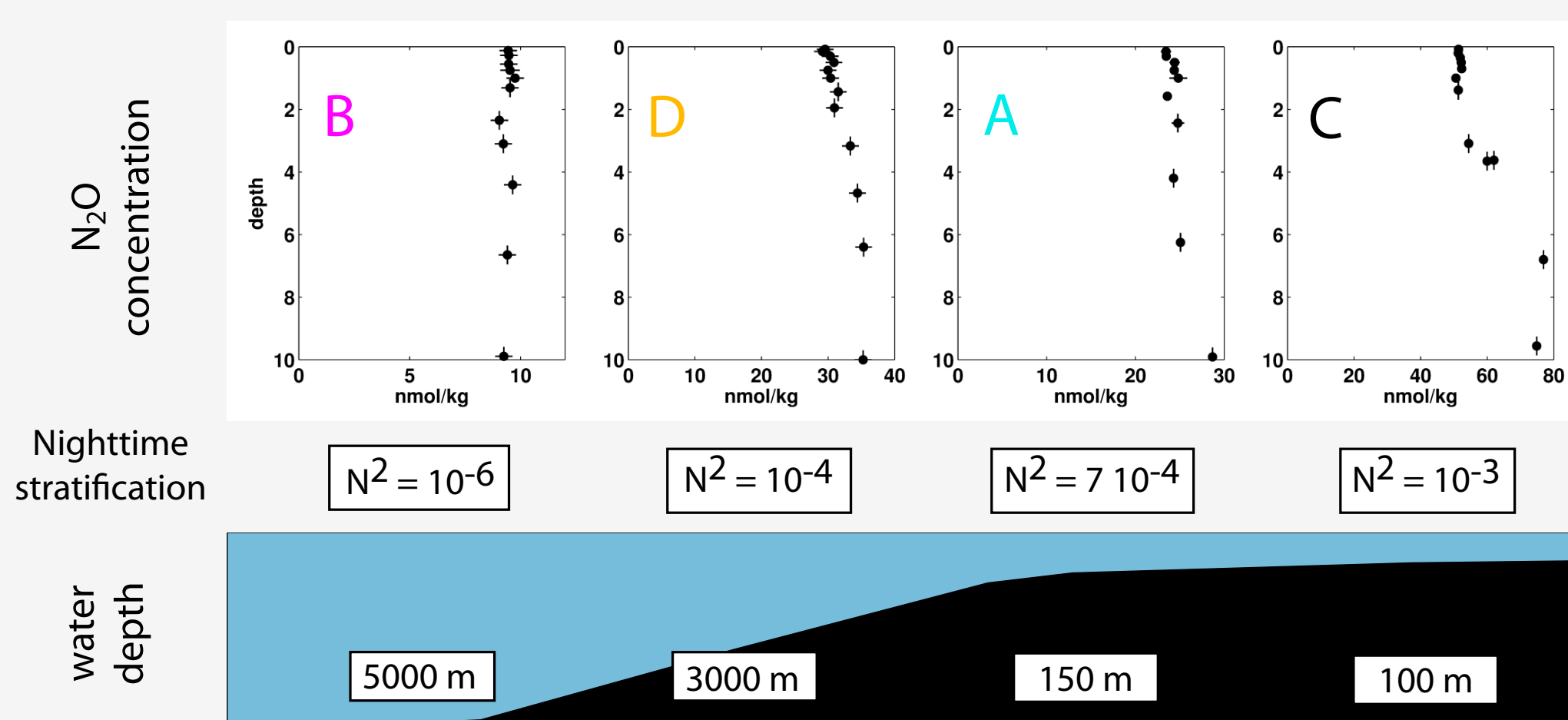
### N<sub>2</sub>O measurements during Meteor cruise M91 in December 2012

Shallow sampling away from ship's influence

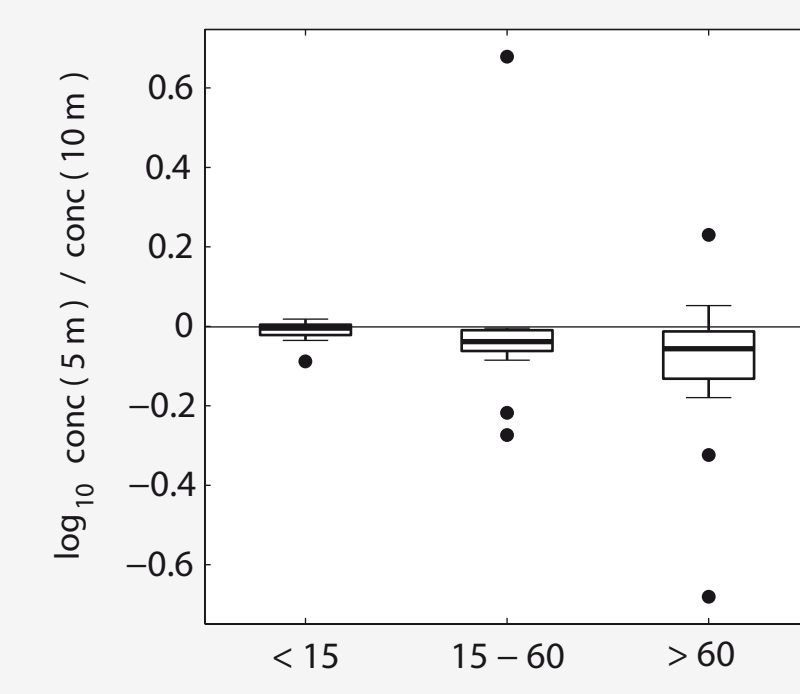


## Near-surface N<sub>2</sub>O gradients exist - associated with shallow nighttime stratification

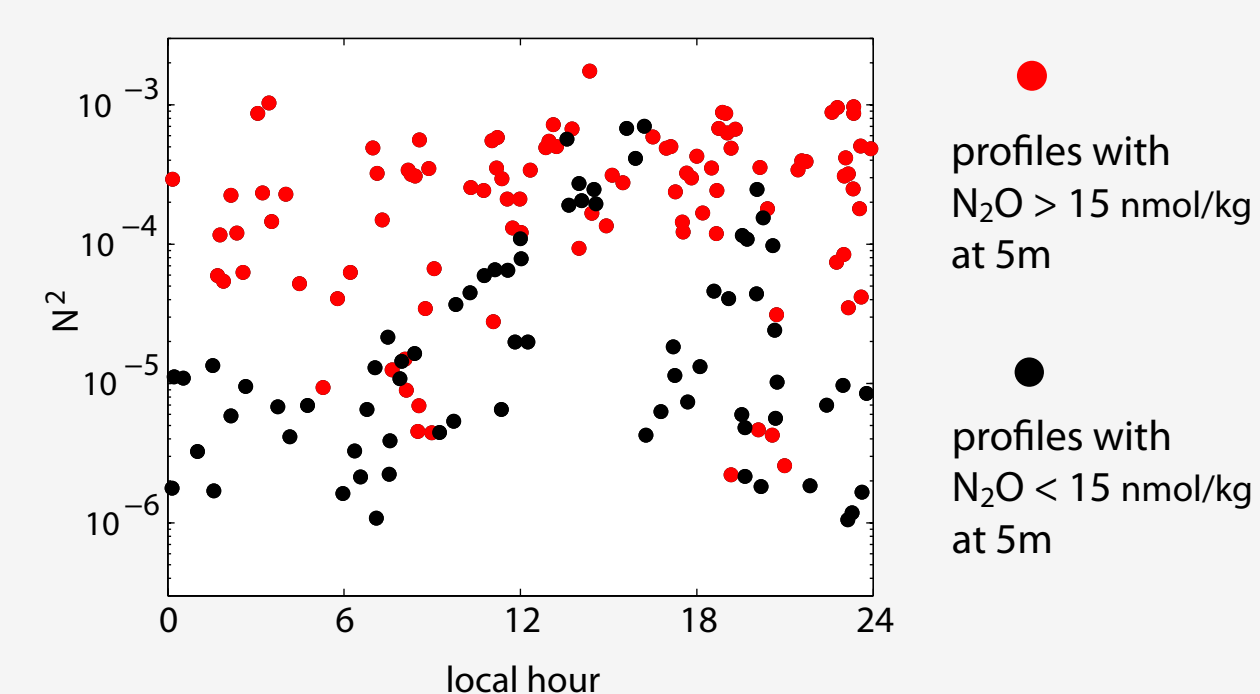
Vertical concentration gradients in top layer exist and vary regionally. Existence of strong N<sub>2</sub>O gradient is related to strong N<sup>2</sup> during night.



Ship based observations also indicate that N<sub>2</sub>O gradients are associated with higher N<sub>2</sub>O concentrations and nighttime stratification.

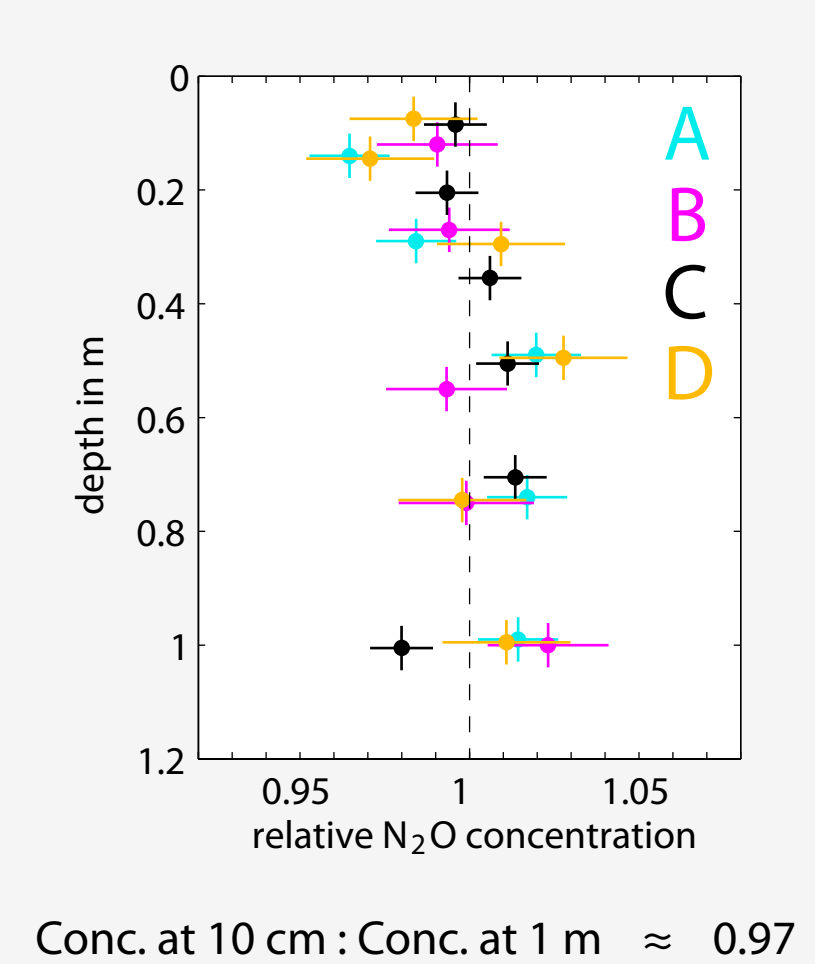


Ratio of N<sub>2</sub>O at 5m and N<sub>2</sub>O at 10m from 45 CTD casts



Stratification of top 10m vs. time of day for regions of high and low N<sub>2</sub>O concentrations.

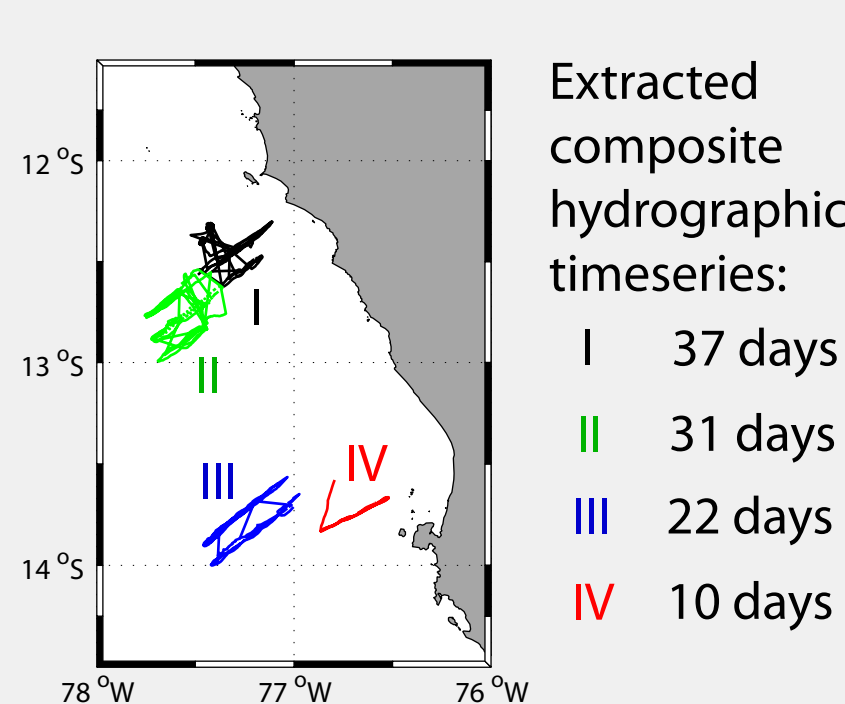
Top 1 meter: barely any gradient



Conc. at 10 cm : Conc. at 1 m ≈ 0.97

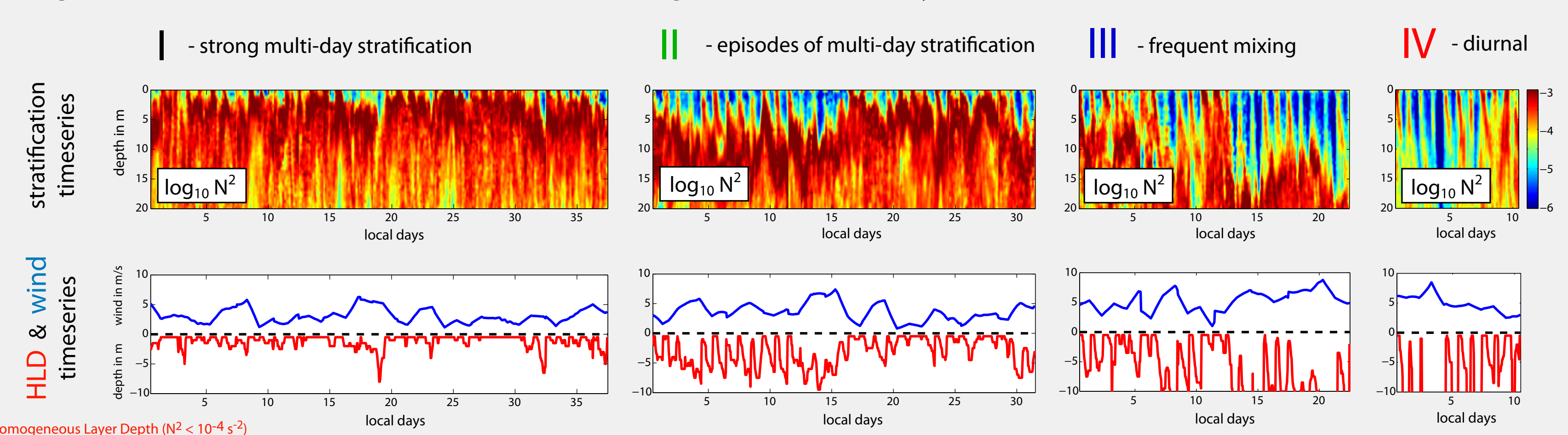
## Existence of multi-day near-surface stratification is verified by glider surveys

### Glider fleet in Jan/Feb 2013

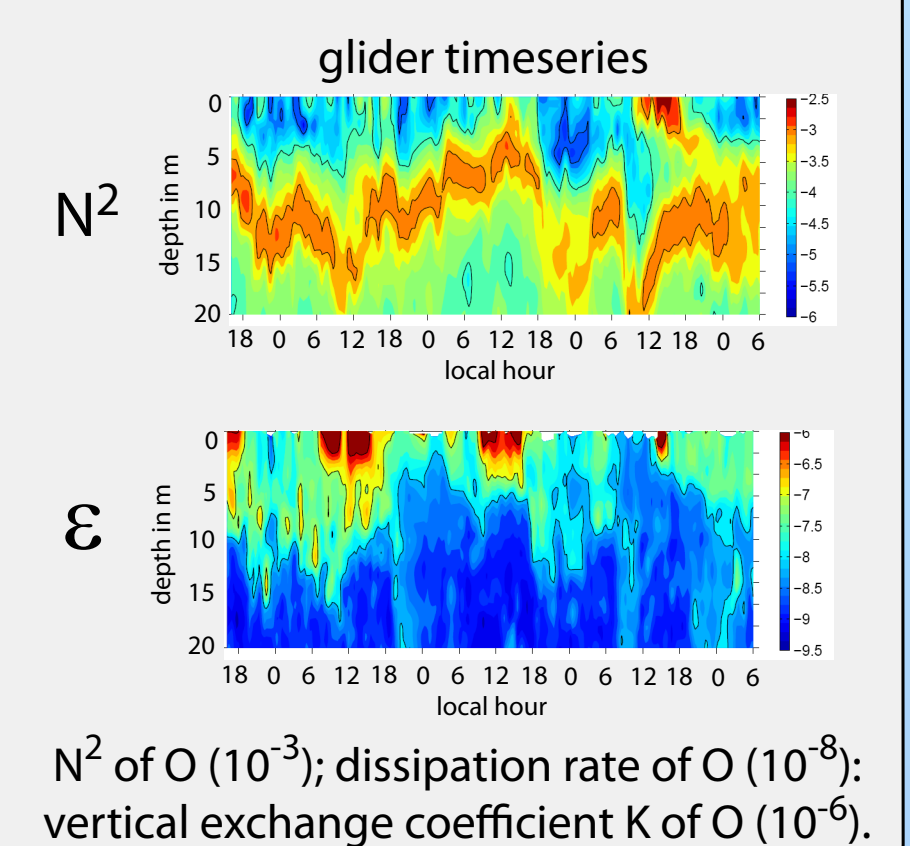


In total 250 glider days were performed by 8 gliders in 4 main regions, recording hydrography.

### Regional stratification timeseries with different grades of multi-day stratification



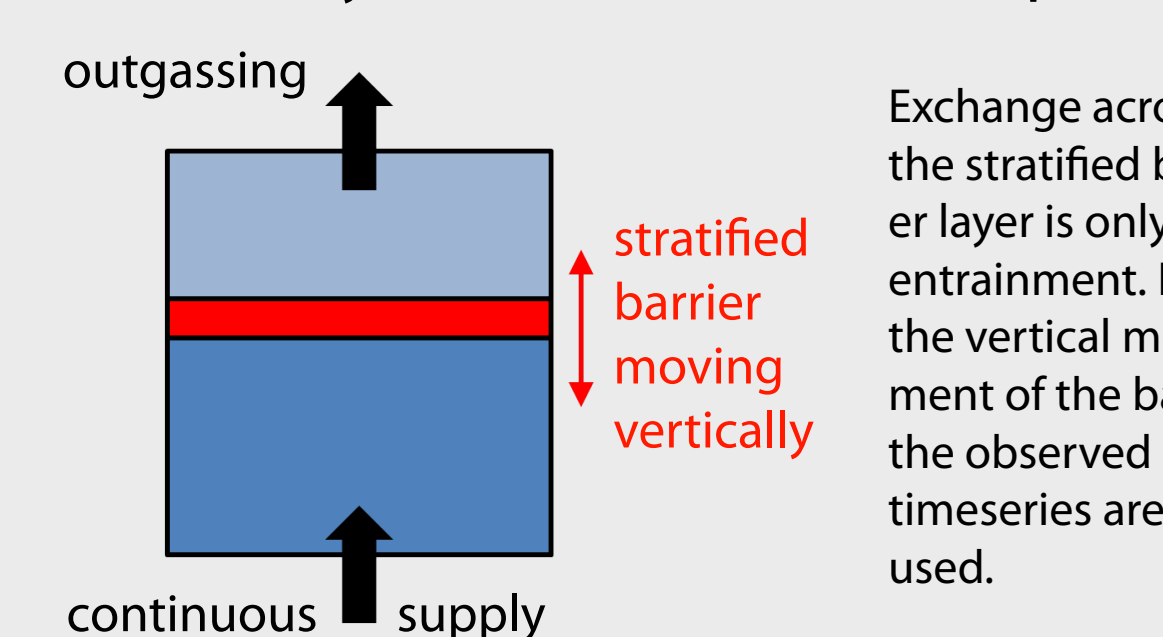
The moving stratified layer is extremely low in mixing



N<sup>2</sup> of O (10<sup>-3</sup>); dissipation rate of O (10<sup>-8</sup>); vertical exchange coefficient K of O (10<sup>-6</sup>).

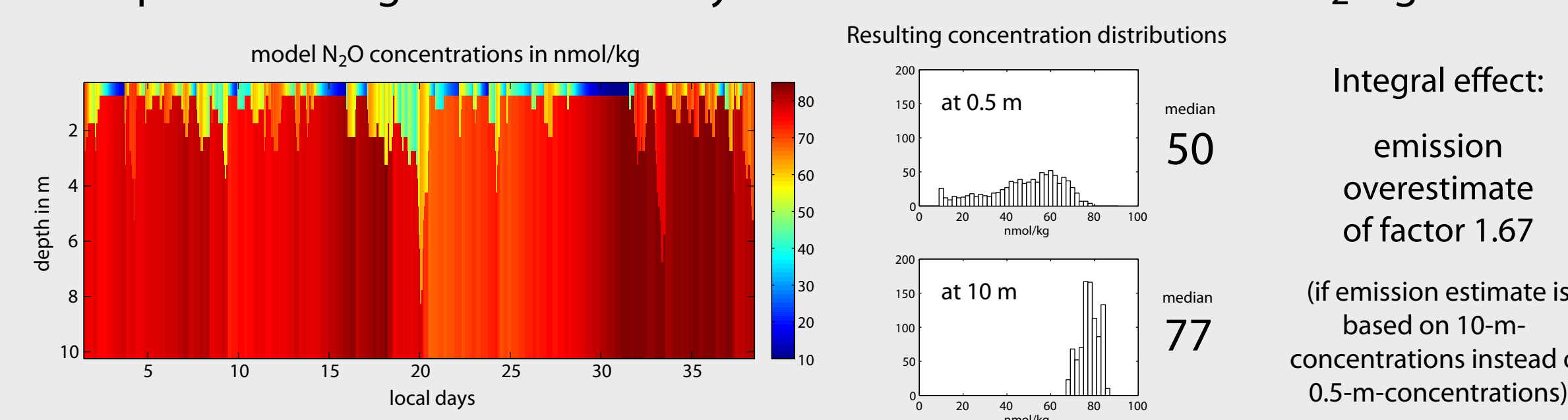
## A 1-D model constrained by the glider timeseries can reproduce the N<sub>2</sub>O gradients

### 1-D two layer model of N<sub>2</sub>O transport



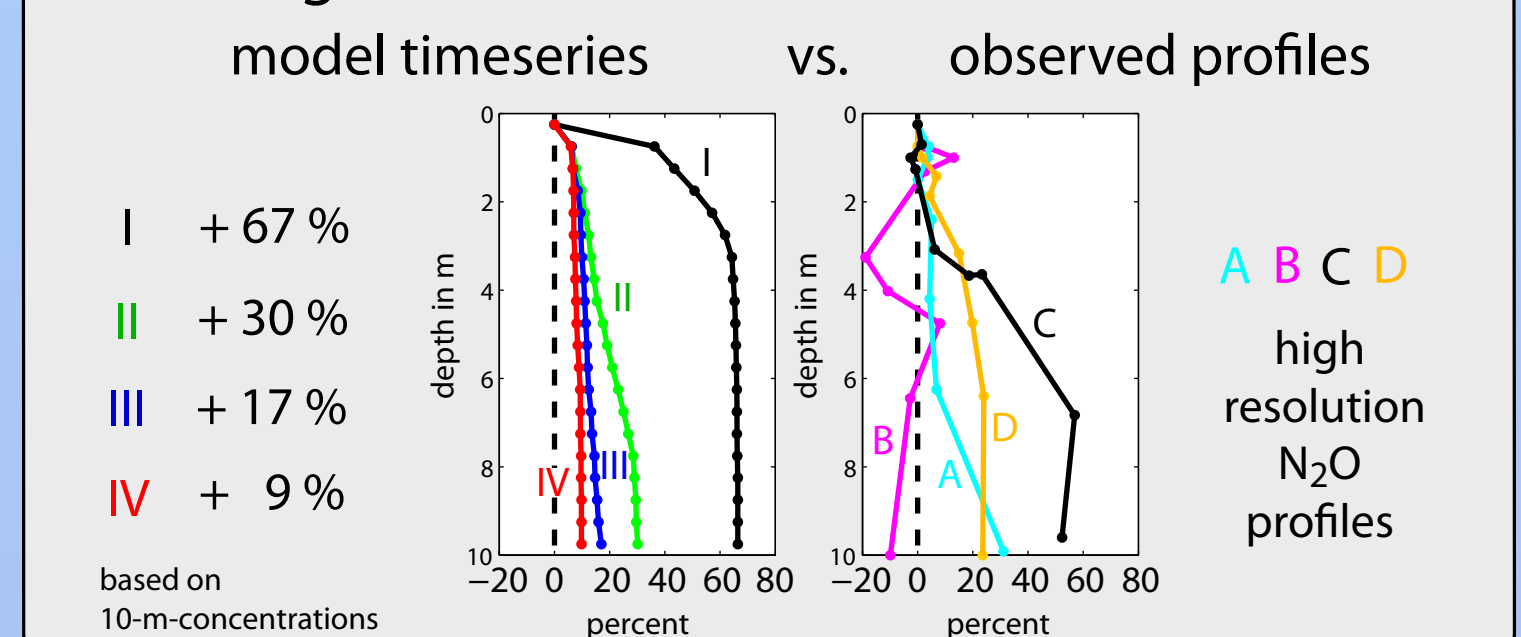
Exchange across the stratified barrier layer is only via entrainment. For the vertical movement of the barrier the observed HLD timeseries are used.

### Example run: Region I - multi-day stratification causes distinct N<sub>2</sub>O gradient



Integral effect:  
emission overestimate of factor 1.67  
(if emission estimate is based on 10-m-concentrations instead of 0.5-m-concentrations)

### Resulting overestimation of emissions:



**Conclusion:** Multi-day (not diurnal) stratification seems the necessary condition here to cause considerable near-surface N<sub>2</sub>O gradients and bias of emission estimates.